# Sustainability of Digital Formats: Planning for Library of Congress Collections

Search this site

Go

# MPEG-4, Advanced Video Coding (Part 10) (H.264)

>> Back

**Table of Contents**

- Identification and description
- Local use
- Sustainability factors
- Quality and functionality factors
- File type signifiers
- Notes
- Format specifications
- Useful references

## Format Description Properties ⓘ

- ID: fdd000081
- Short name: MPEG-4_AVC
- Content categories: moving-image
- Format Category: encoding
- Other facets: unitary, binary, sampled
- Last significant FDD update: 2011-12-05
- Draft status: Full

## Identification and description ⓘ

| Full name | ISO/IEC 14496-10:2003. Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding (formal name); MPEG-4, Advanced Video Coding (common name) |
|---|---|
| Description | Compression encoding for video identical to ITU-T (International Telecommunications Union-Telecommunication Standardization Sector) recommendation ITU-T H.264. MPEG-4_V based on H.263 is a sibling that appears to be less widely adopted. In order to distinguish the two, technical writers sometimes call this encoding *H.264 video* and the other *MPEG-4 video*. An overview of AVC encoding is provided in Notes below.<br><br>This page is used in this website to represent encodings with no profile indicated. The established profiles for MPEG-4_AVC are listed (and linked) as subtypes below. They are defined in terms of bitstream characteristics and relate to the conformance of players. The *Baseline*, *Main*, and *Extended* profiles were specified in Annex A of the 2003 edition of the standard. Four *High* profiles, part of a group called FRExt (*Fidelity Range Extensions*) were approved in 2005. All profiles can be wrapped in MP4_FF_2. There is another coding variant: MPEG-4_AVC_EXT, a specialized subset of AVC that appears not to be a "profile," although it requires the use of its own wrapper: MP4_FF_AVCE. Comments welcome. |

| Production phase | Generally a final-state (end-user delivery) format, although the FRExt additions will serve middle-state postproduction and archiving uses. |
|---|---|
| **Relationship to other formats** | |
| Used by | MP4_FF_2_AVC, MPEG-4 File Format, Version 2, with Advanced Video Coding (No Profile Indicated) |
| Used by | QTV_MP4_AVC, QuickTime Video, MPEG-4 Advanced Video Coding |
| Used by | Matroska_AVC, Matroska File Format with MPEG-4, Advanced Video Coding (Part 10) (H.264) |
| Used by | HEIF, High Efficiency Image File (HEIF) Format |
| Used by | EPUB_3_0, EPUB, Electronic Publication, Version 3.0 (2011). ISO/IEC TS 30135:2014 |
| Used by | Other file wrappers, not documented here |
| Has subtype | MPEG-4_AVC_BP, MPEG-4 Advanced Video Coding, Baseline Profile |
| Has subtype | MPEG-4_AVC_MP, MPEG-4 Advanced Video Coding, Main Profile |
| Has subtype | MPEG-4_AVC_EP, MPEG-4 Advanced Video Coding, Extended Profile |
| Has subtype | MPEG-4_AVC_HP, MPEG-4 Advanced Video Coding, High Profile |
| Has subtype | MPEG-4_AVC_H10P, MPEG-4 Advanced Video Coding, High 10 Profile |
| Has subtype | MPEG-4_AVC_H422P, MPEG-4 Advanced Video Coding, High 4:2:2 Profile |
| Has subtype | MPEG-4_AVC_H444P, MPEG-4 Advanced Video Coding, High 4:4:4 Profile |
| Has subtype | MPEG-4_AVC_EXT, MPEG-4, Advanced Video Coding, Non-FRExt Extensions |

## Local use ⓘ

| LC experience or existing holdings | |
|---|---|
| LC preference | |

## Sustainability factors ⓘ

| Disclosure | Open standard. Developed through ISO technical program JTC 1/SC 29 for coding of audio, picture, multimedia and hypermedia information by Working Group 11 (WG11) aka the Moving Picture Experts Group (MPEG). |
|---|---|
| Documentation | ISO/IEC 14496-10. Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding. Also published by ITU as ITU-T H.264. |
| Adoption | The underlying encoding, sometimes under the name of ITU-T H.264, is being adopted in various sectors. In 2004, for example, a key group of Japanese broadcasters adopted the format for transmission to mobile telephones and other devices, and the format received provisional approval for use in DVD systems, where it will coexist with MPEG-2 and Microsoft's VC-9 video codec (see WMV9_PRO). In 2005, the ability of MPEG-4_AVC to support high definition contributed to further adoptions by direct broadcast satellite (DBS) services in the United States (DirecTV) and in Europe. The FRExt high-end profiles are being introduced in 2005; adoption not determined.<br><br>The specifications for the video-capable iPod introduced by Apple in late 2005 state that device will play H.264 video in the Baseline Profile, i.e., |

| | MPEG-4_AVC_BP. This was reinforced in early 2006, as Google began to offer downloadable videos, including files for the iPod that have the .mp4 extension and an encoding variously listed as "H.264" or "avc1" (MPEG-4_AVC_BP). |
| | It is worth noting that adoptions of AVC/H.264 are generally in closed systems like satellite television or mobile phone delivery. In contrast, *digital terrestrial broadcasting* to homes in the United States and several other nations is governed by the ATSC (Advanced Television Systems Committee). The ATSC specifications require the use of MPEG-2 compression. |
| **Licensing and patents** | See MP4_FF_2. |
| **Transparency** | Depends upon algorithms and tools to read; will require sophistication to build tools. |
| **Self-documentation** | Pertains to the file format; see MP4_FF_2. |
| **External dependencies** | None |
| **Technical protection considerations** | Pertains to the file format; see MP4_FF_2. |

## Quality and functionality factors ⓘ

| Moving Image | |
|---|---|
| **Normal rendering** | Good support. |
| **Clarity (high image resolution)** | For all profiles, MPEG-4_AVC (MPEG-4 Advanced Video Coding, part 10) is more efficient than the MPEG-4_V (MPEG-4 Visual Coding, part 2), i.e., MPEG-4_AVC provides better quality at the same data rate, or equal quality at a lower data rate.<br><br>Clarity is excellent for the profiles covered by the Fidelity Range Extensions (FRExt), which extend to lossless or near lossless levels, and support 4:4:4 chroma and bit depths as high as 12. See MPEG-4_AVC_HP, MPEG-4_AVC_H10P, MPEG-4_AVC_H422P, and MPEG-4_AVC_H444P.<br><br>Clarity in other profiles ranges from moderate to very good, given that chroma subsampling is limited to 4:2:0, and that these profiles will generally be implemented with significant amounts of lossy compression.See MPEG-4_AVC_BP, MPEG-4_AVC_MP, and MPEG-4_AVC_EP.<br><br>The outcome in all cases will depend on the extent of compression and the encoder used. All profiles support both progressive and interlaced video, at resolutions from sub-QCIF to HDTV.<br><br>[See Notes below for more detail on resolution terms.] |
| **Functionality beyond normal rendering** | Not investigated at this time. |
| Sound | |
| **Normal rendering** | Not relevant; see MP4_FF_2. |
| **Fidelity (high audio resolution)** | Not relevant; see MP4_FF_2. |
| **Multiple channels** | Not relevant; see MP4_FF_2. |
| **Functionality beyond normal rendering** | Not relevant; see MP4_FF_2. |

# File type signifiers and format identifiers ⓘ

| Tag | Value | Note |
|---|---|---|
| **Filename extension** | See related format. | See MP4_FF_2 |
| **Internet Media Type** | See related format. | See MP4_FF_2 |
| **Magic numbers** | See related format. | See MP4_FF_2 |
| **File type brand (ISO Base Media File Format)** | See note. | Indicated in file wrapper and relates to "brands" defined in ISO_BMFF and registered in the MP4RA registry. Wrapping MPEG-4_V bitstreams in MP4_FF_1 would occasion the use of *mp41*; in MP4_FF_2, use of *mp42*. See also the 2004 version of Part 15 of the MPEG-4 standard (for an AVC-specific file format), pp. 2-9, 13. Note: the specification of the AVC-specific file format may have been updated as a more general specification for how to use encodings such as AVC in the ISO_BMFF format. Comments welcome. |
| **Indicator for profile, level, version, etc.** | See note. | Codes for *profile_idc* are provided in Annex A of the MPEG-4 Part 10 standard (aka ITU-T H.264). As of the 2003 version this covered the Baseline, Main, and Extended Profiles. Four "high" profiles were added in the 2005 version for fidelity range extensions. Additional profiles have been added over the years. |
| **Pronom PUID** | See note. | PRONOM has no corresponding entry as of July 2022. |
| **Wikidata Title ID** | Q212633 | See https://www.wikidata.org/wiki/Q212633. |

# Notes ⓘ

| General | From the specification: "The coded representation specified in the syntax is designed to enable a high compression capability for a desired image quality. The algorithm is not lossless, as the exact source sample values are typically not preserved through the encoding and decoding processes. A number of techniques may be used to achieve highly efficient compression. Encoding algorithms (not specified in this Recommendation \| International Standard) may select between inter and intra coding for block-shaped regions of each picture. Inter coding uses motion vectors for block-based inter prediction to exploit temporal statistical dependencies between different pictures. Intra coding uses various spatial prediction modes to exploit spatial statistical dependencies in the source signal for a single picture. Motion vectors and intra prediction modes may be specified for a variety of block sizes in the picture. The prediction residual is then further compressed using a transform to remove spatial correlation inside the transform block before it is quantised, producing an irreversible process that typically discards less important visual information while forming a close approximation to the source samples. Finally, the motion vectors or intra prediction modes are combined with the quantised transform coefficient information and encoded using either variable length codes or arithmetic coding." (p. ix) The specification also includes a number of additional elements. <br><br>The FRExt (*Fidelity Range Extensions*) as drafted in 2005 featured higher quality profiles, including one that is sometimes described as "lossless," which may mean that the second sentence in the preceding is no longer accurate. The four FRExt profiles are described on the following pages: <br><br>• MPEG-4_AVC_HP <br>• MPEG-4_AVC_H10P |
|---|---|

| | |
|---|---|
| | • MPEG-4_AVC_H422P<br>• MPEG-4_AVC_H444P (described as lossless).<br><br>Terms used for spatial resolution: QCIF stands for Quarter Common Intermediate Format (176 pixels by 144 lines), CIF is Common Intermediate Format (352 pixels by 288 lines), while HDTV is High Definition Television (various, including 1920 pixels by 1080 lines).<br><br>See also MP4_FF_2. |
| **History** | See MP4_FF_2. |

## Format specifications ⓘ

- Full text of all editions of ITU-T H.264 through the 13th edition (2019) are available from ITU. Links to a selection of editions are provided below.
  - ITU Recommendation ITU-T H.264 (05/2003) (https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=6312). Record for 1st edition. Includes Baseline, Main, and Extended profiles. Lists all editions
  - ITU Recommendation ITU-T H.264 (03/2005) (https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=7825). Record for 2nd edition. Added four "High" profiles for fidelity range extensions. Lists all editions.
  - ITU Recommendation ITU-T H.264 (01/2012) (https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=11466). Record for 2012 (7th) edition. Lists all editions
  - ITU Recommendation ITU-T H.264, Edition 13 (06/2019) (https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=13903). Record for 2019 edition. Includes a total of fifteen profiles. Lists all editions
  - Recommendation H.264: Advanced video coding for generic audiovisual services (06/19) (https://www.itu.int/rec/T-REC-H.264-201906-I). Download page for 2019 (13th) edition
  - Persistent identifier for record for 2019 (13th) edition (http://handle.itu.int/11.1002/1000/13903).
  - H.264.2 : Reference software for ITU-T H.264 advanced video coding (https://www.itu.int/rec/T-REC-H.264.2-201602-I/en). Download page for reference decoder and encoder software
- The H.264 standard has also been published as ISO/IEC 14496-10 but only loosely synchronized. ISO provides catalog records which sometimes have previews including table of contents and front matter. Reference software for decoding and encoding is published as ISO/IEC 14496-5 in a series of amendments. The software is available from the list of Publicly Available Standards from the ISO/IEC Information Technology Task Force (ITTF).
  - ISO/IEC 14496-10:2003 Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding (https://www.iso.org/standard/37729.html). Catalog record only
  - ISO/IEC 14496-10:2014 Information technology — Coding of audio-visual objects — Part 10: Advanced Video Coding (https://www.iso.org/standard/66069.html). Catalog record and preview
  - Text of ISO/IEC 14496-10:2014 | from ITTF list of Publicly Available standards (https://standards.iso.org/ittf/PubliclyAvailableStandards/c066069_ISO_IEC_14496-10_2014.zip). 2014 ISO/IEC (8th) edition.
  - ISO/IEC FDIS 14496-10 Information technology — Coding of audio-visual objects — Part 10: Advanced Video Coding (https://www.iso.org/standard/75400.html). As of November 2020, a new ISO/IEC edition of the specification is in preparation.

## Useful references

### URLs

- RFC 3640: RTP Payload Format for Transport of MPEG-4 Elementary Streams (https://doi.org/10.17487/RFC3640). Extended/updated by RFC 5691
- RFC 6416: RTP Payload Format for MPEG-4 Audio/Visual Streams (https://doi.org/10.17487/RFC6416). Supersedes RFC 3016.
- RFC 3016: RTP Payload Format for MPEG-4 Audio/Visual Streams (2000) (https://doi.org/10.17487/RFC3016). Obsoleted by RFC 6416
- MPEG-4 Advanced Video Coding from Moving Picture Experts Group website (http://mpeg.chiariglione.org/standards/mpeg-4/advanced-video-coding). MPEG document #N7314. By Jens-Rainer Ohm, Gary Sullivan. July 2005.

- [MPEG-4 Advanced Video Coding Emerges (2005) | by Randy Hoffner](https://web.archive.org/web/20130922202856/http://www.tvtechnology.com/opinions/0087/mpeg--advanced-video-coding-emerges/184320) (https://web.archive.org/web/20130922202856/http://www.tvtechnology.com/opinions/0087/mpeg--advanced-video-coding-emerges/184320).
- [Video Coding and Analytics | Technologies and Solutions | H.264/MPEG4-AVC | H.264 Overview](https://www.hhi.fraunhofer.de/en/departments/vca/technologies-and-solutions/h264-avc/h264-overview.html) (https://www.hhi.fraunhofer.de/en/departments/vca/technologies-and-solutions/h264-avc/h264-overview.html). Fraunhofer Institute (Germany). Covers multiple aspects of H.264 AVC coding, including subpages with extensive technical information.
- [The H.264/AVC Advanced Video Coding Standard:Overview and Introduction to the Fidelity Range Extensions (2004)](https://www.fastvdo.com/spie04/spie04-h264OverviewPaper.pdf) (https://www.fastvdo.com/spie04/spie04-h264OverviewPaper.pdf). By Sullivan, Gary J., Pankaj Topiwala, and Ajay Luthra. Presented at the SPIE Conference on Applications of Digital Image Processing XXVII, Special Session on Advances in the New Emerging Standard: H.264/AVC, August, 2004.
- ISO/IEC 14496-15 was a companion standard for an AVC file format through 2010. [Note: The 2014 update to ISO/IEC 14496-15 was given a new name: "Carriage of network abstraction layer (NAL) unit structured video in ISO base media file format." The compilers of this resource have not located a clear public explanation of this change. [Comments welcome](#).]
    - [ISO/IEC 14496-15:2004 Information technology -- Coding of audio-visual objects -- Part 15: Advanced Video Coding (AVC) file format](https://www.iso.org/standard/38573.html) (https://www.iso.org/standard/38573.html). Catalog record only.
    - [ISO/IEC 14496-15:2010 Information technology -- Coding of audio-visual objects -- Part 15: Advanced Video Coding (AVC) file format](https://www.iso.org/standard/55980.html) (https://www.iso.org/standard/55980.html). Catalog record only. 2014 update to standard with same number has new name: "Carriage of network abstraction layer (NAL) unit structured video in ISO base media file format."
    - [Resources related to MPEG-4, Part 15 from MPEG website.](https://mpeg.chiariglione.org/standards/mpeg-4/carriage-nal-unit-structured-video-iso-base-media-file-format) (https://mpeg.chiariglione.org/standards/mpeg-4/carriage-nal-unit-structured-video-iso-base-media-file-format).
- [ITU Telecommunication Standardization Sector](http://www.itu.int/en/ITU-T/Pages/default.aspx) (http://www.itu.int/en/ITU-T/Pages/default.aspx). Home page for ITU-T.
- See also [MP4_FF_2](#).